

Infra-Sound, Low Frequency Noise & Vibration from Wind Turbines

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Noise & Vibration

Some Basic Concepts

- Loudness (~ Noise Level)
Measured in decibels (dB)
- Vibration Level
Measured as acceleration (m/s^2), velocity (m/s) or displacement (m)
- Pitch / Rate of Vibration (~ Frequency)
Measured in Cycles per Second (Hz)



Low Frequency Noise, Infra-Sound & Vibration

- Infra-Sound: $<20\text{Hz}$
- Low Frequency Noise: $10\text{Hz} - 160\text{Hz}$
- Vibration: “at point of entry into the subject”



Infrasound – The Issues

- Down-wind turbines produced high levels of infrasound at blade passing frequency & harmonics.
- Press articles stimulated by G.P. interest caused extensive concern regarding UK turbine wind farm sites.



Reported Effects of Infrasound

- Sleep Disorders
- Headache
- Vertigo
- Nystagmus
- Nausea & Vomiting
- Mental Changes
- Hallucinations

Dr G Leventhall for DEFRA



When do Infrasound Effects Occur

“There is no reliable evidence that infrasounds below the hearing threshold produce physiological or psychological effects”

Community Noise for WHO

“Much of what has been written about infrasound in the press and in popular books is grossly misleading and should be discounted”

Dr G Leventhall for DEFRA



When do Infrasound Effects not Occur

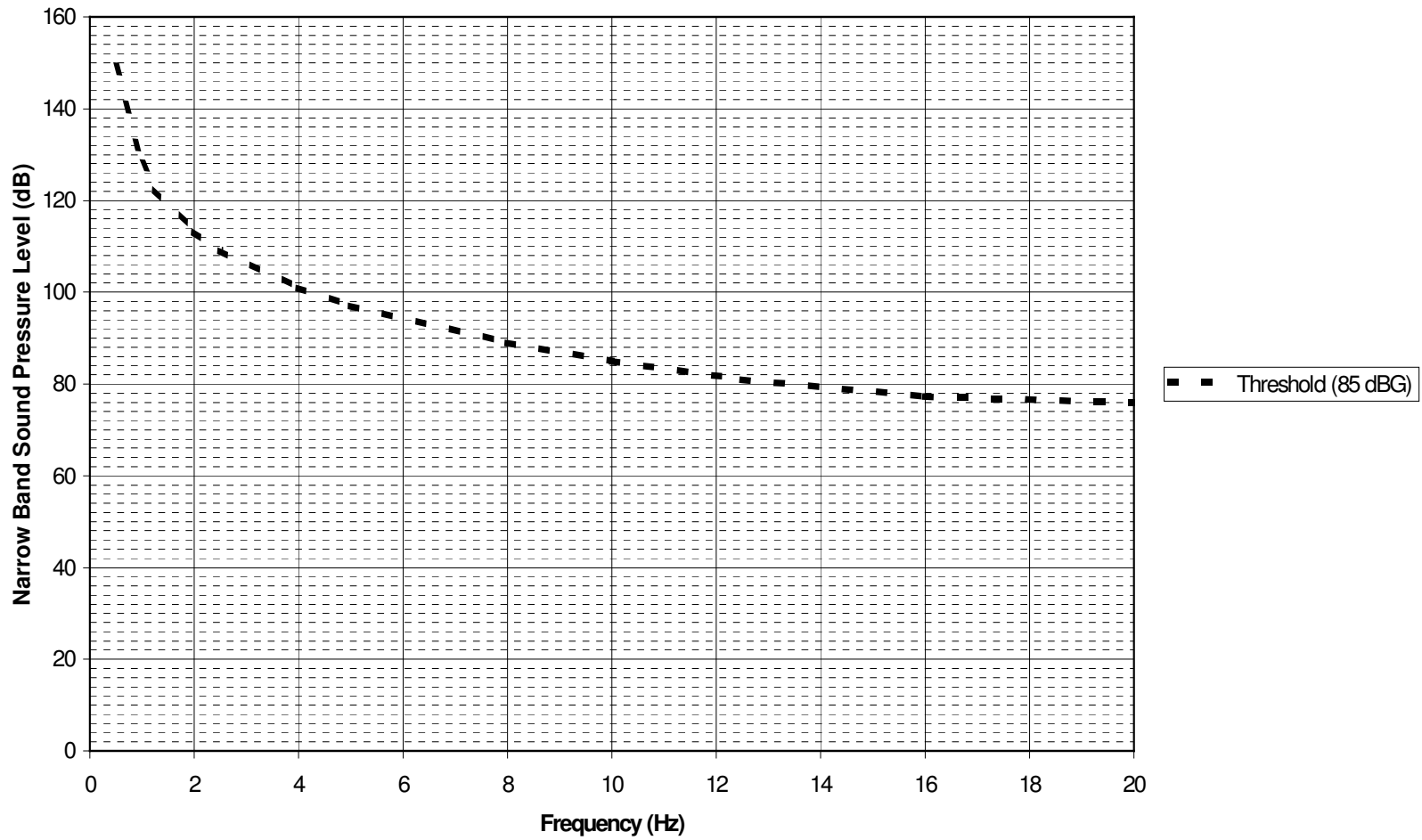
- Almost all UK turbine installation have been upwind turbines leading to negligible infrasound.

“I can state quite categorically that there is no significant infrasound from current designs of wind turbines. To say that there is an infrasound problem is one of the hares which objectors to wind farms like to run. There will not be any effects from infrasound from the turbines”.

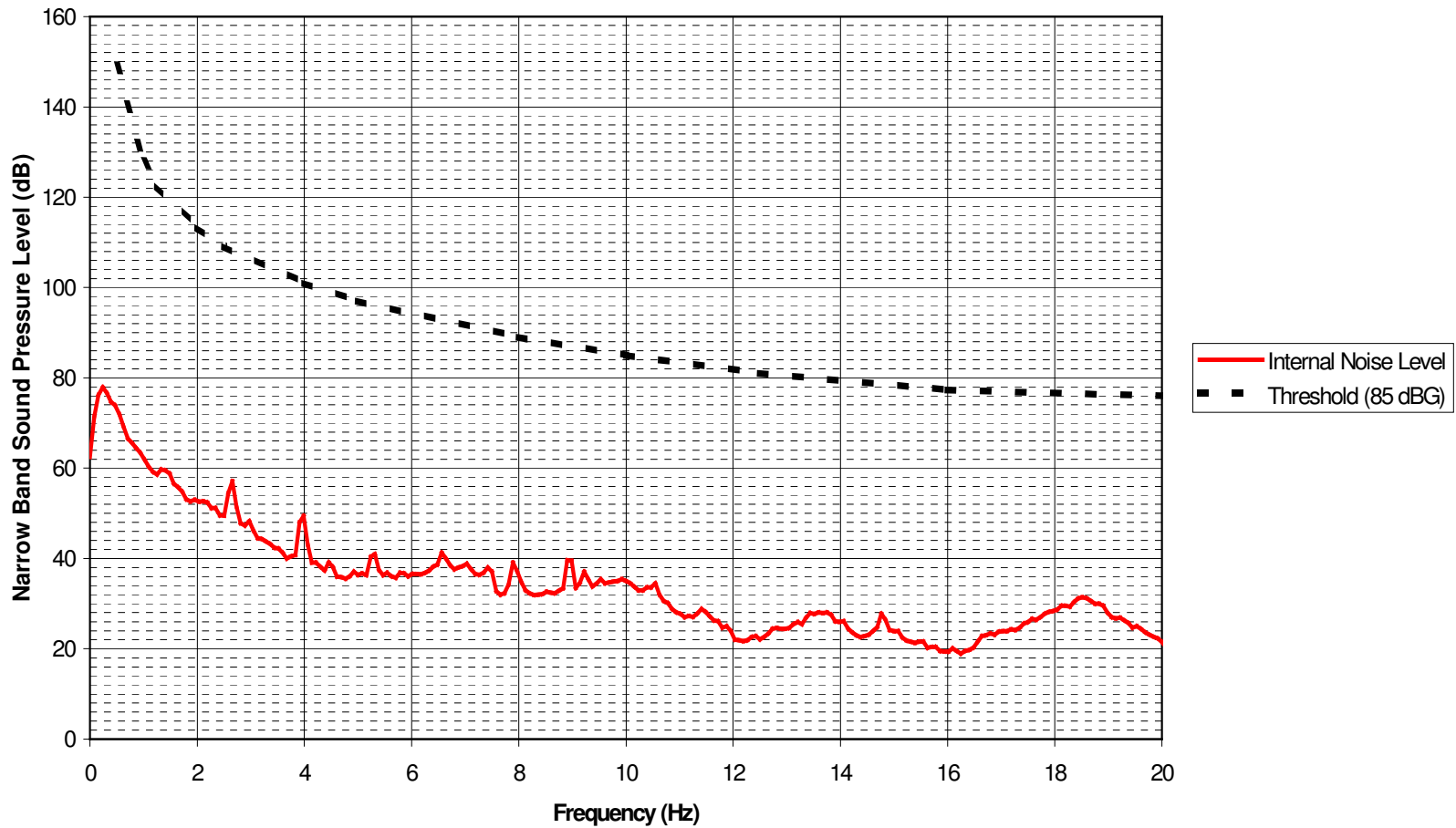
Dr G Leventhall



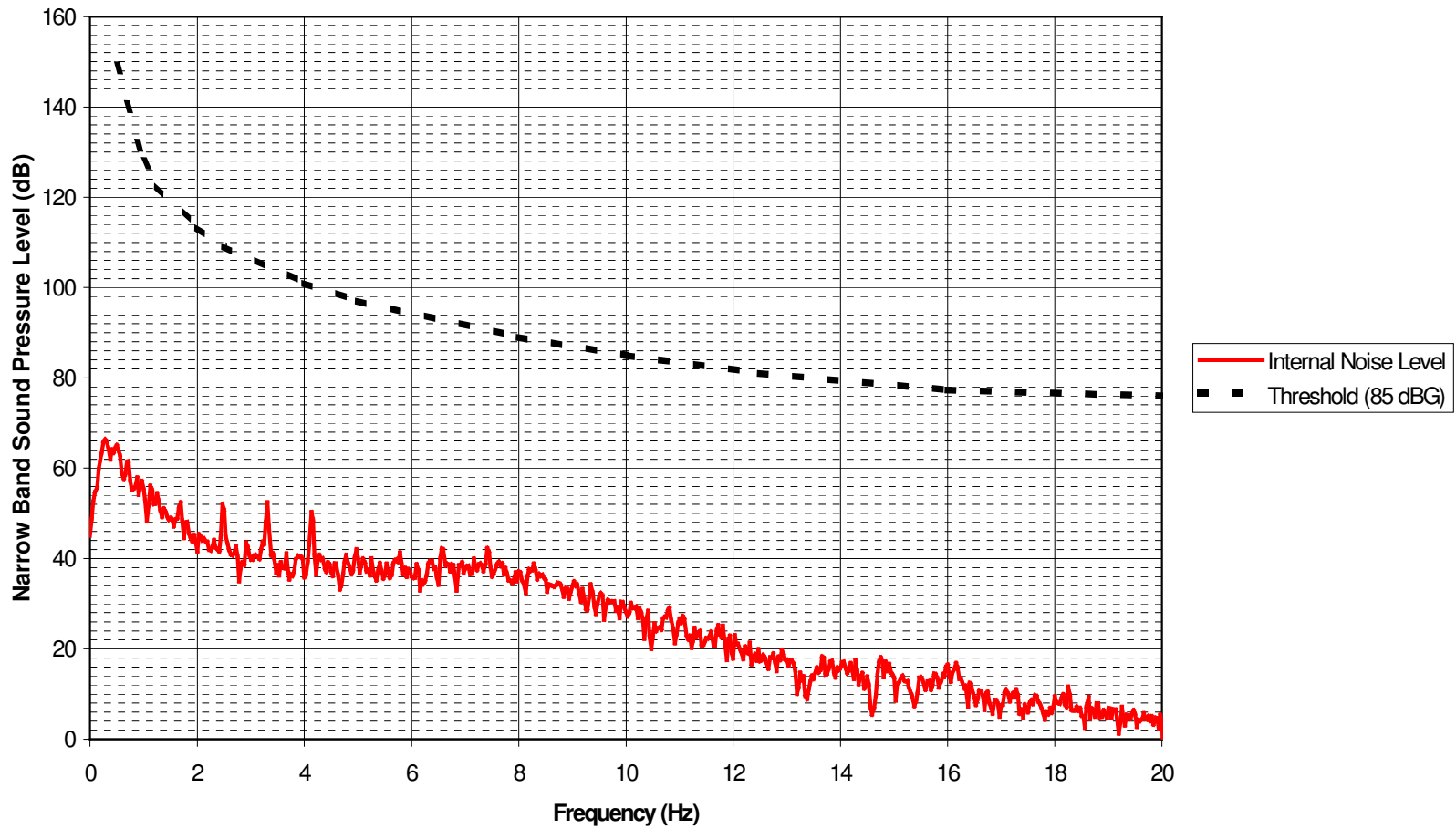
Internal Infra-Sound Levels



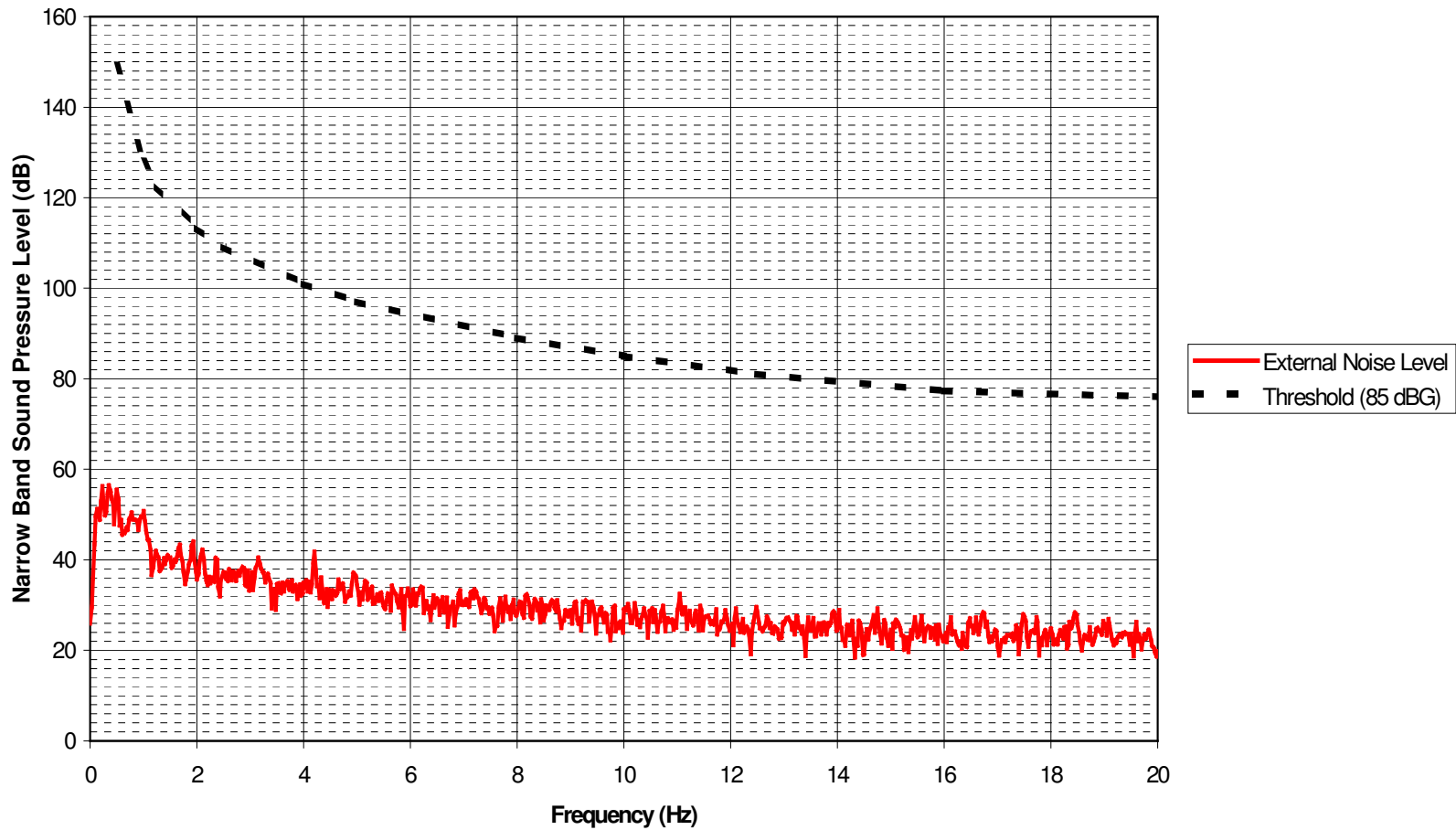
Internal Infra-Sound Levels
Turbine Output Power 500 - 1MW
Nearest Turbine at 500 m



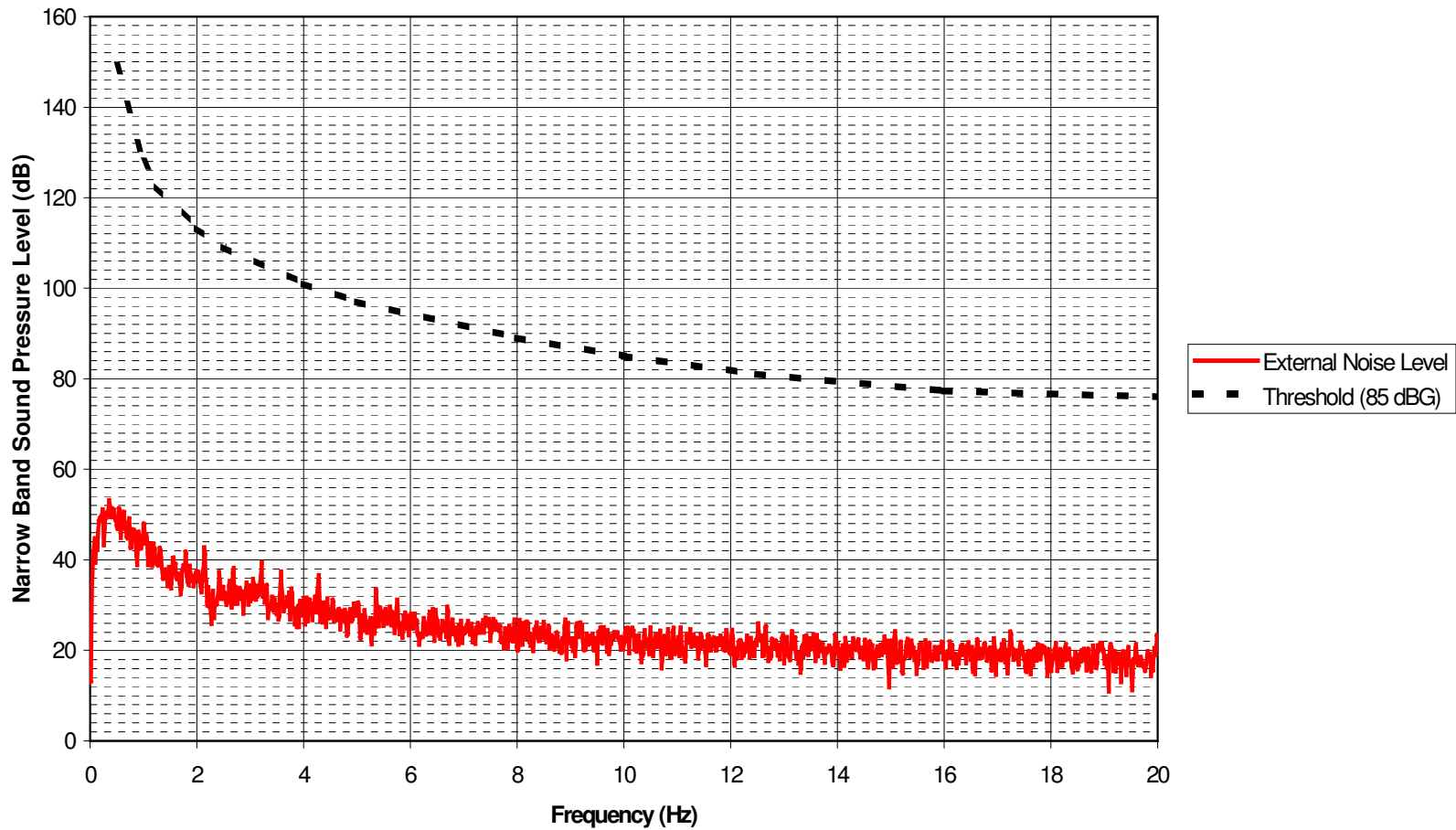
Internal Infra-Sound Levels
Turbine Output Power > 2MW
Nearest Turbine > 2km



External Infra-Sound Levels
Turbine Output Power > 1 - 2 MW
Nearest Turbine at 550 m



External Infra-Sound Levels
Turbine Output Power > 1 - 2 MW
Nearest Turbine at 420 m



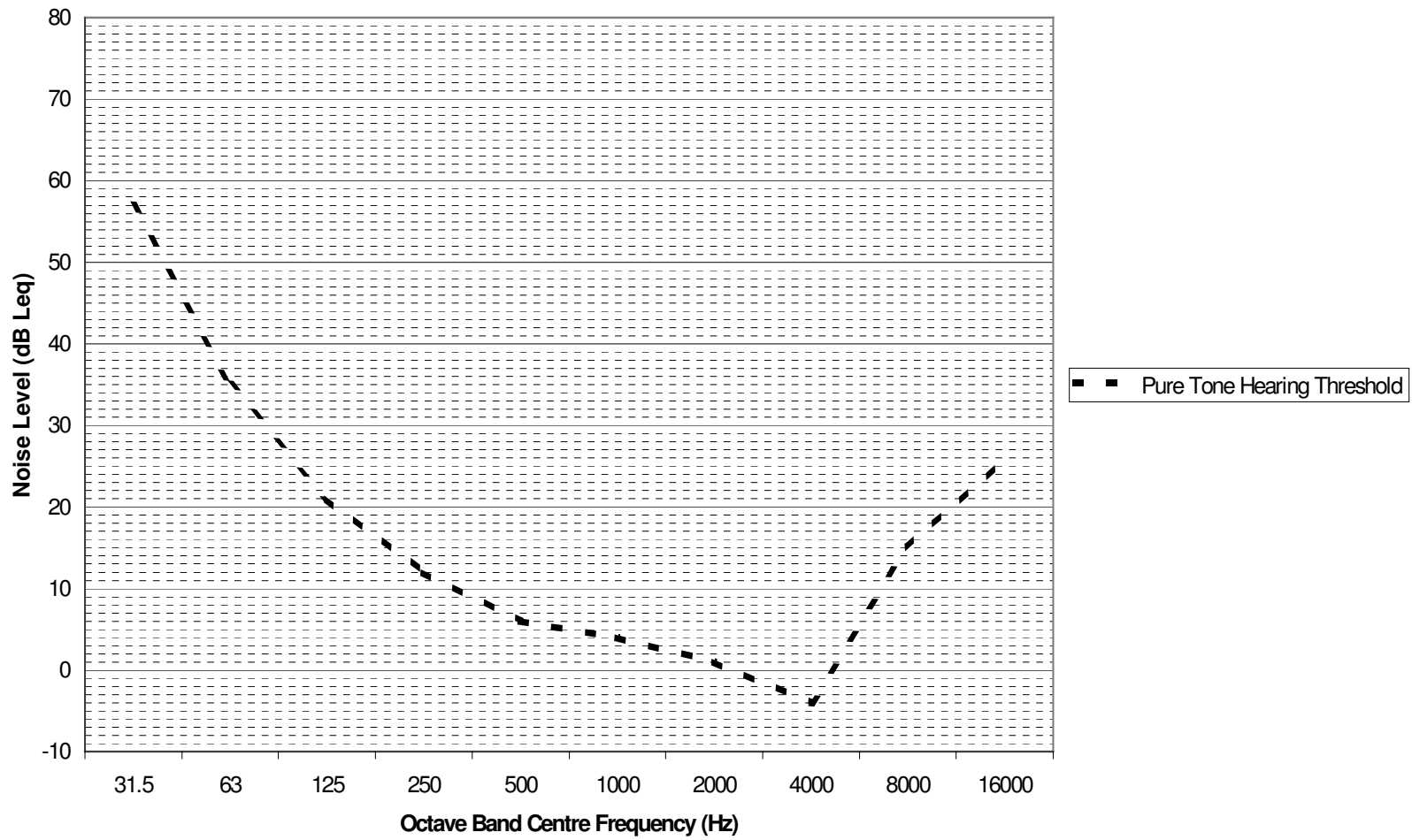
Low Frequency Noise – The Issues

- “It should be noted that low frequency noise, for example, from ventilation systems can disturb rest and sleep even at low sound levels.”
- “For noise with a large proportion of low frequency sounds a still lower guideline (than 30 dBA) is recommended”
- When prominent low frequency components are present, noise measures based on A-weighting are in-appropriate”
- “Since A-weighting underestimates the sound pressure level of noise with low frequency components, a better assessment of health effects would be to use C-weighting”
- “It should be noted that a large proportion of low frequency components in a noise may increase considerably the adverse effects on health”
- “The evidence on low frequency noise is sufficiently strong to warrant immediate concern”

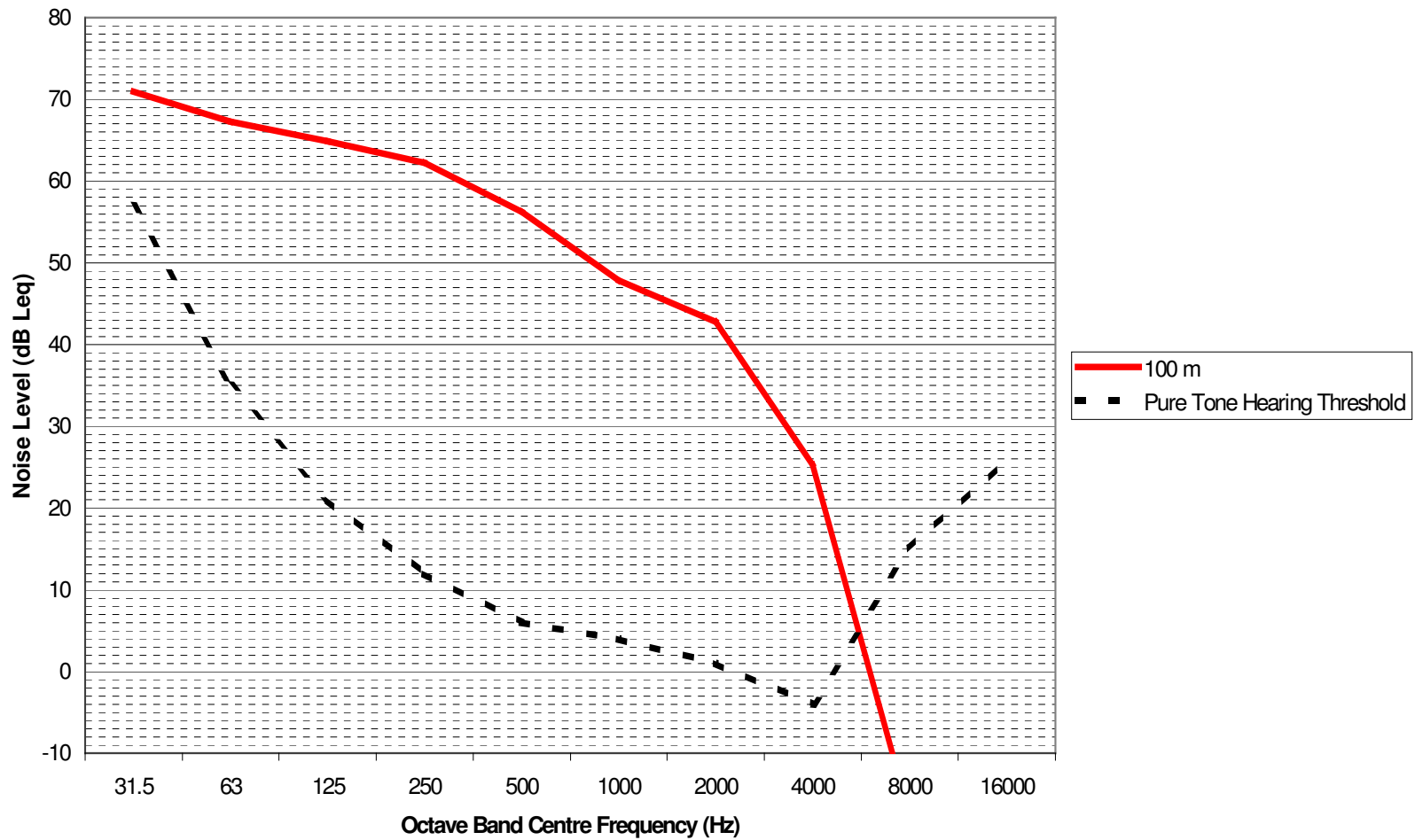
WHO, Guidelines for Community Noise



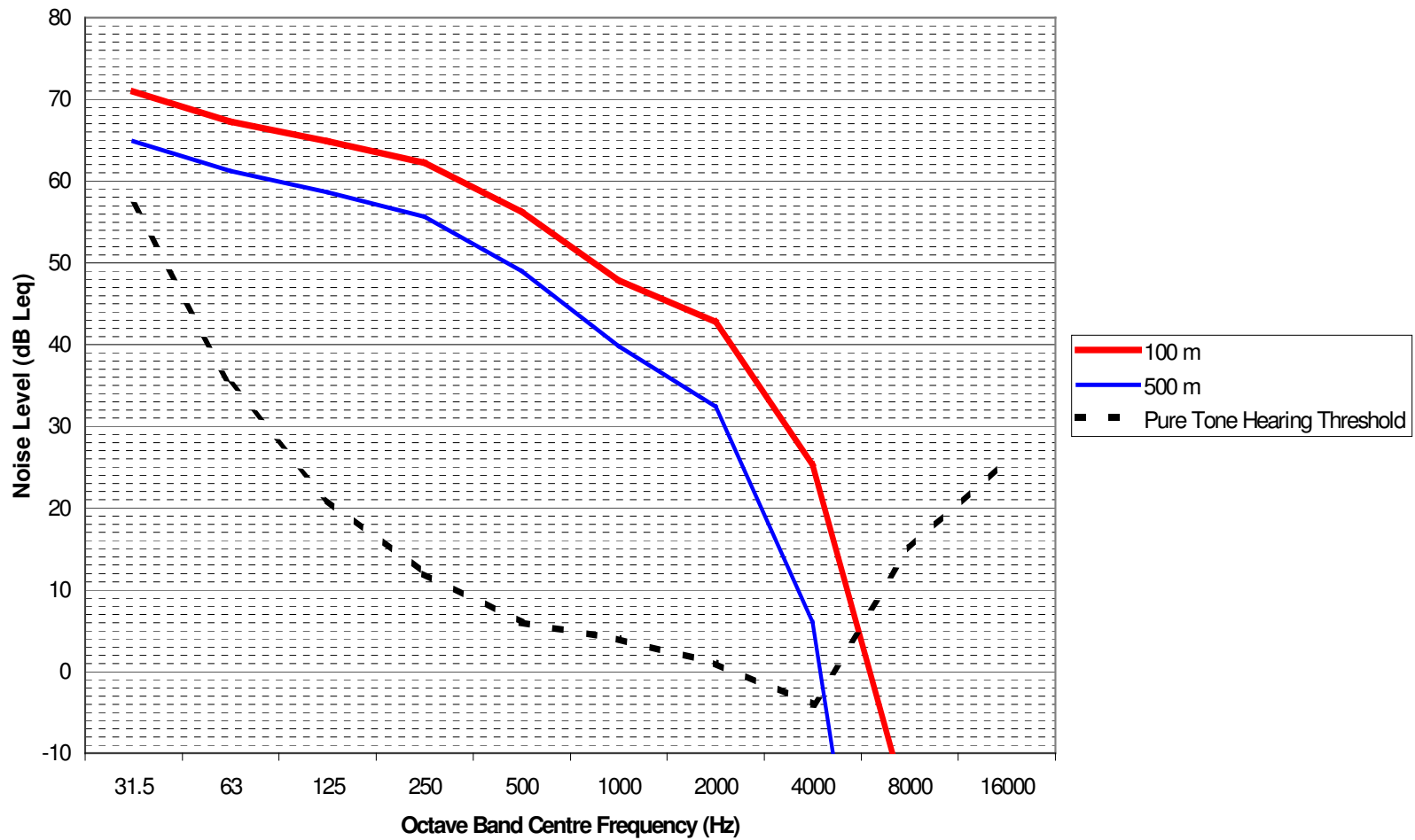
Wind Farm Noise - Spectral Analysis



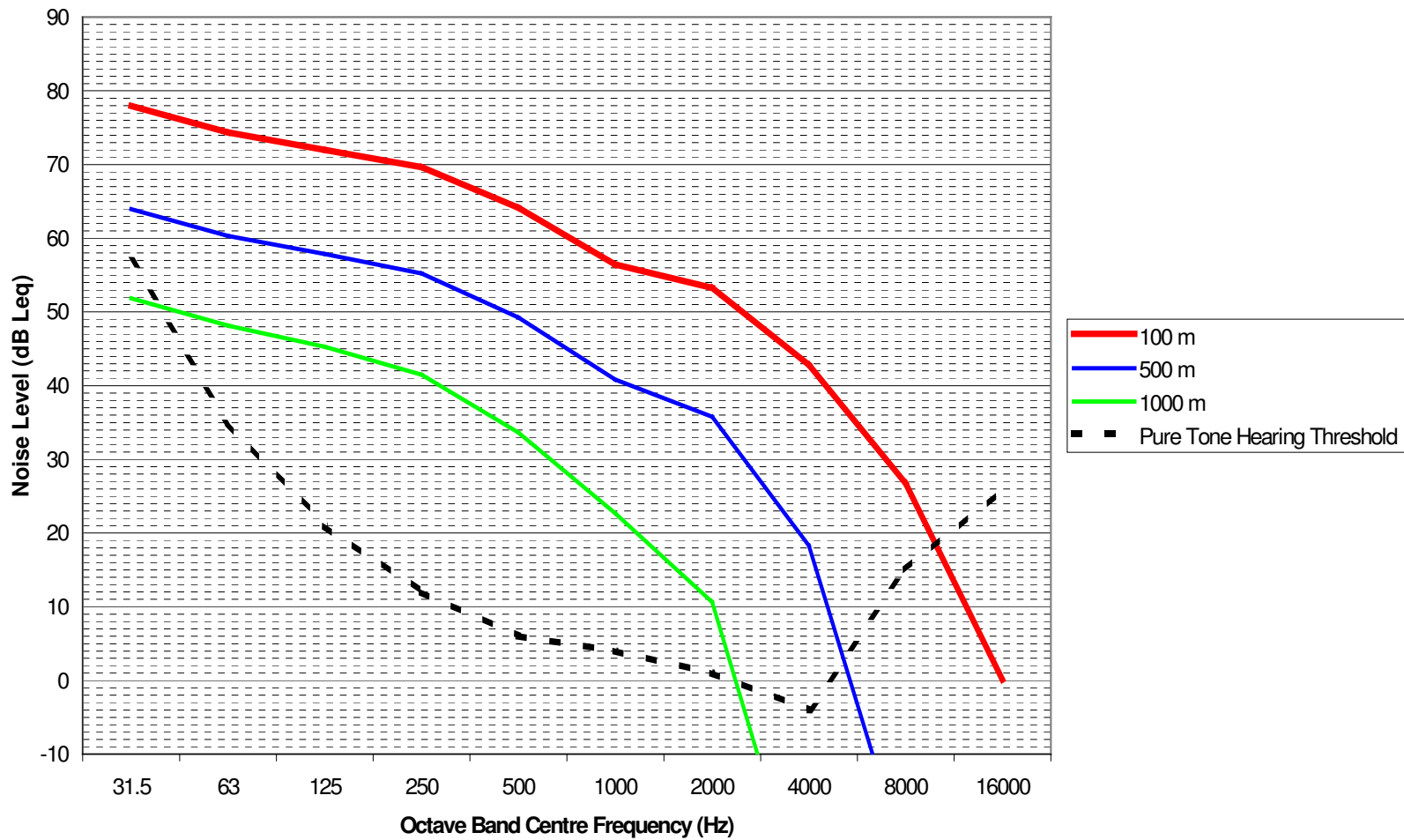
Wind Farm Noise - Spectral Analysis External Noise Levels - 10 Turbines



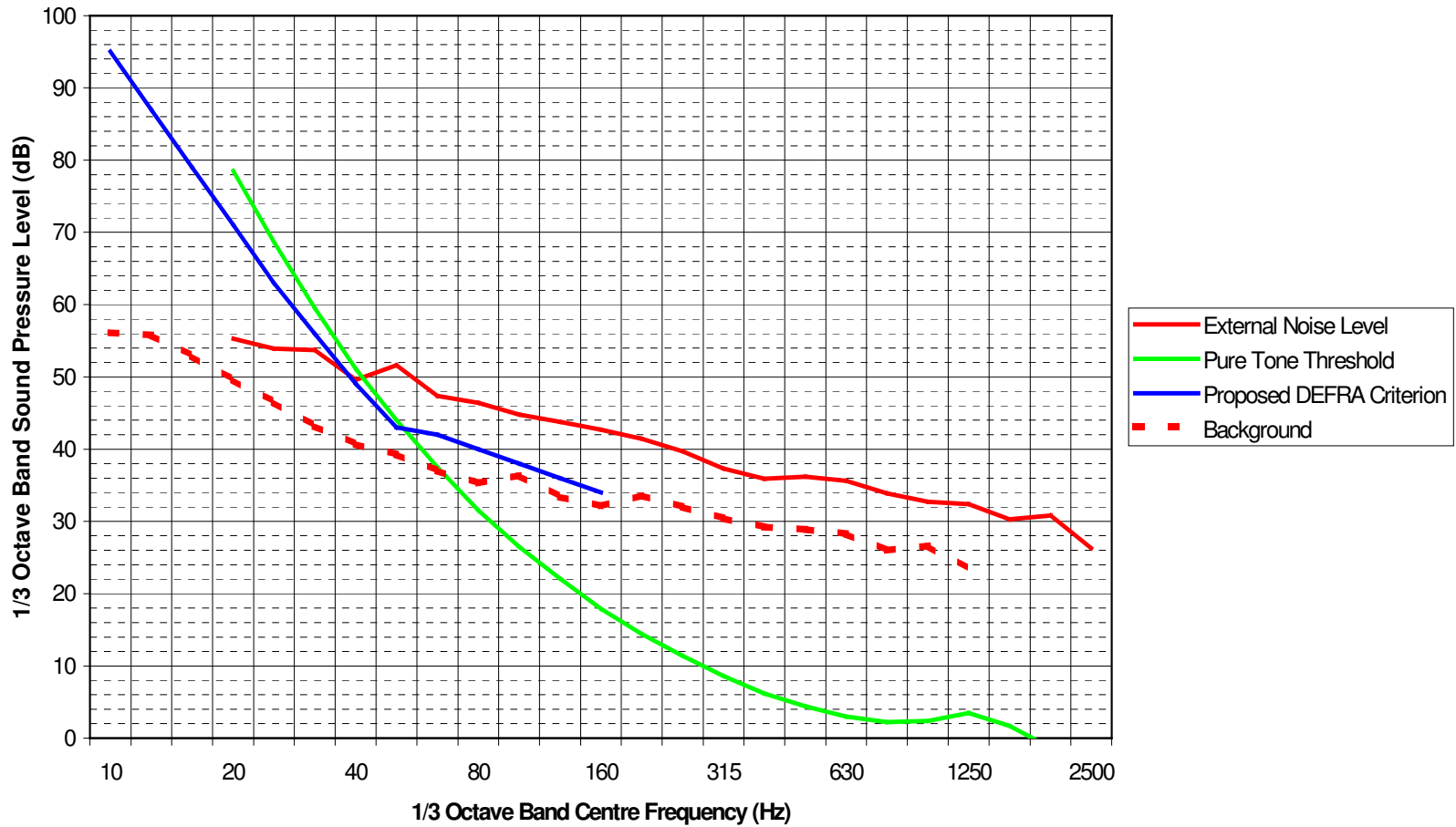
Wind Farm Noise - Spectral Analysis External Noise Levels - 10 Turbines



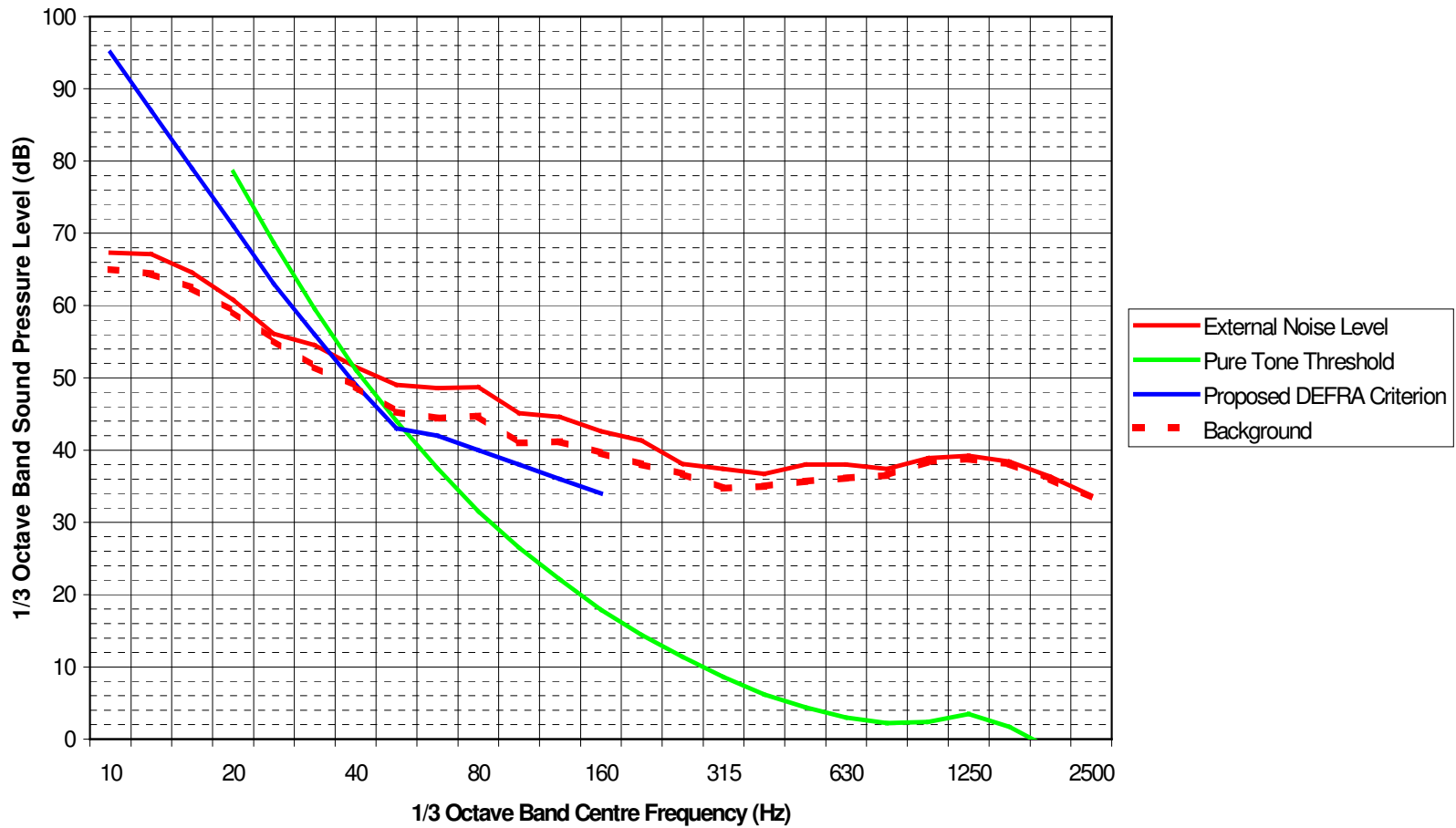
Wind Farm Noise - Spectral Analysis External Noise Levels - 10 Turbines



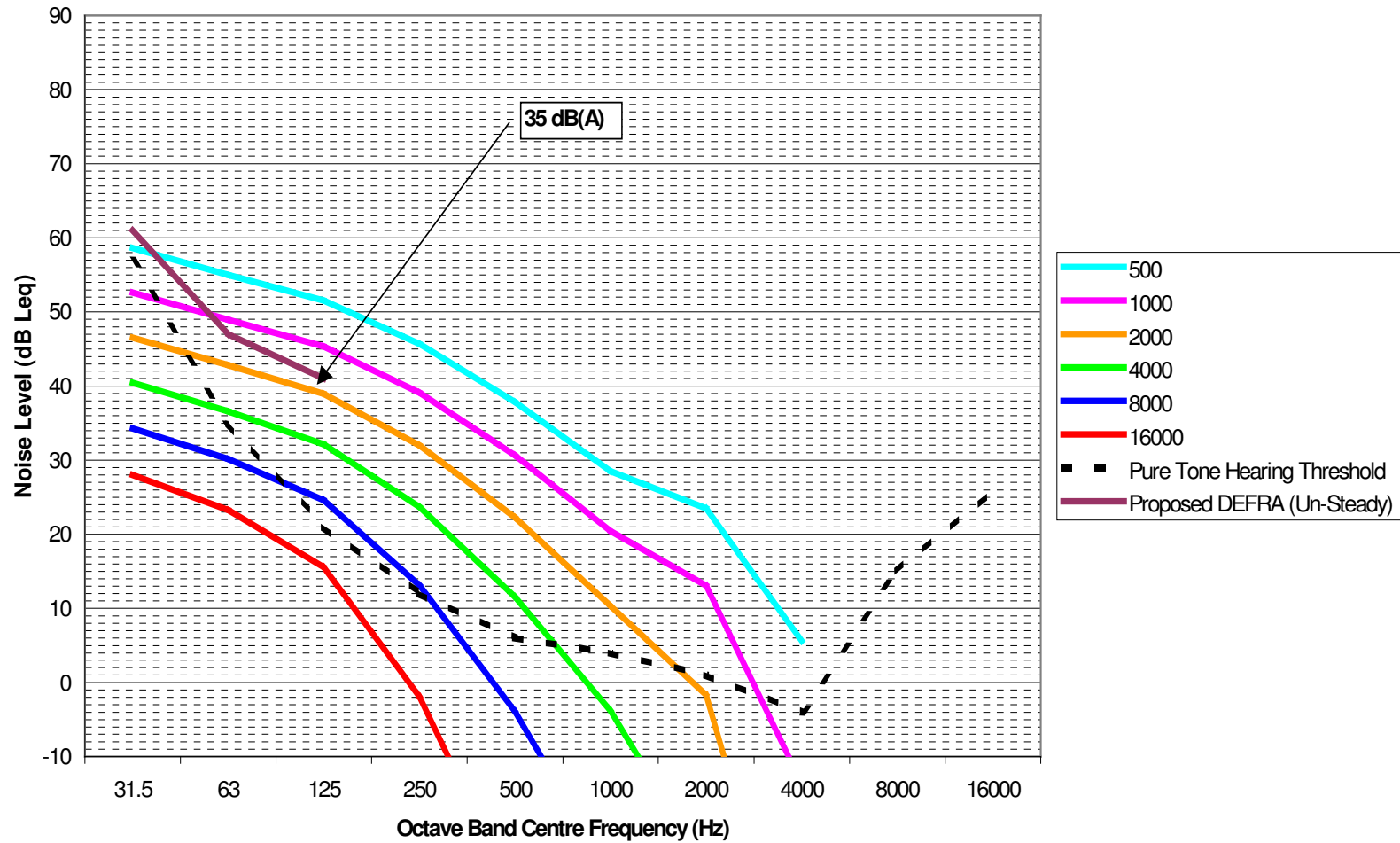
External Noise Level
Turbine Output Power 1 - 2 2MW
Nearest Turbine ~ 500 m



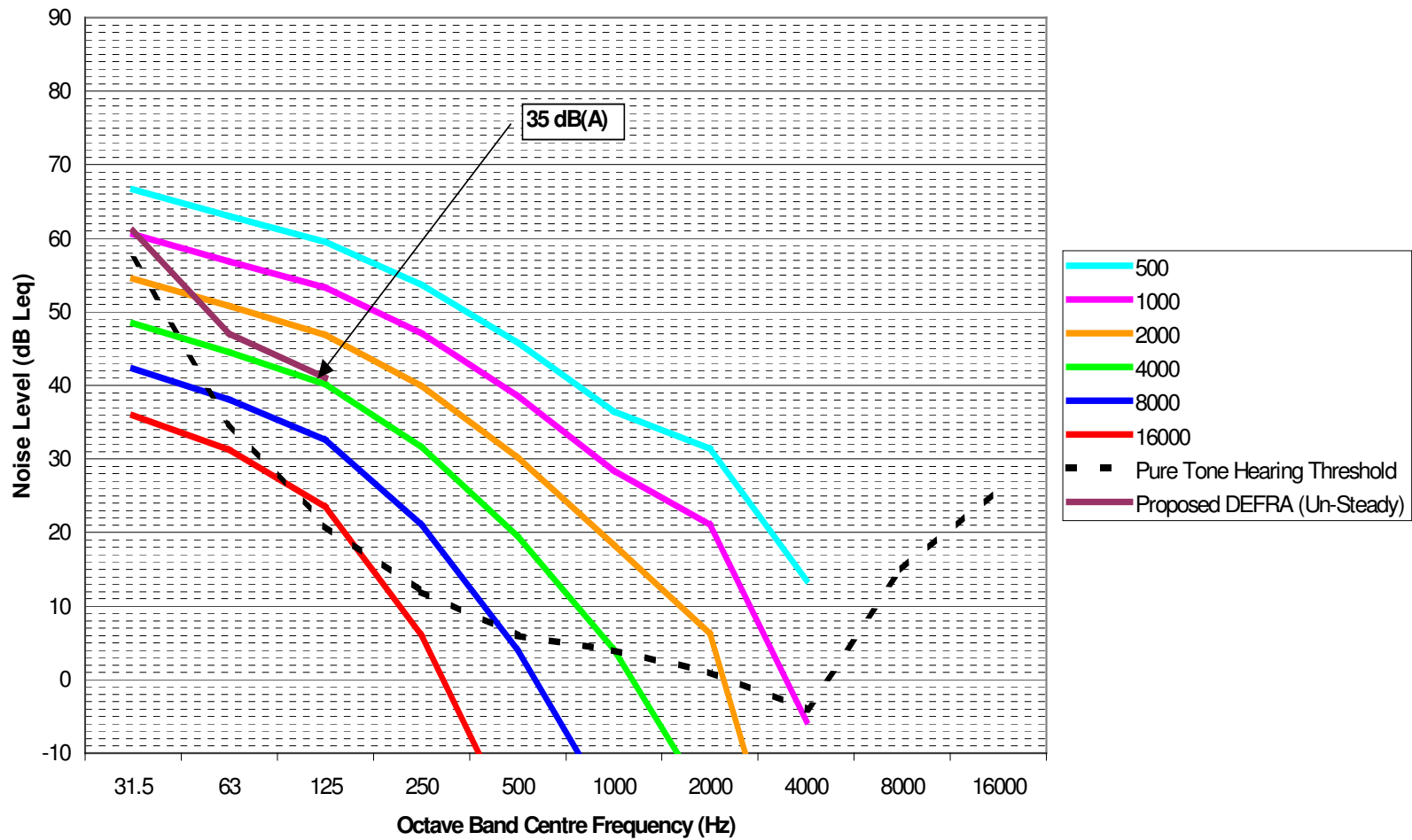
External Noise Level
Turbine Output Power ~ 2MW
Nearest Turbine > 2 km



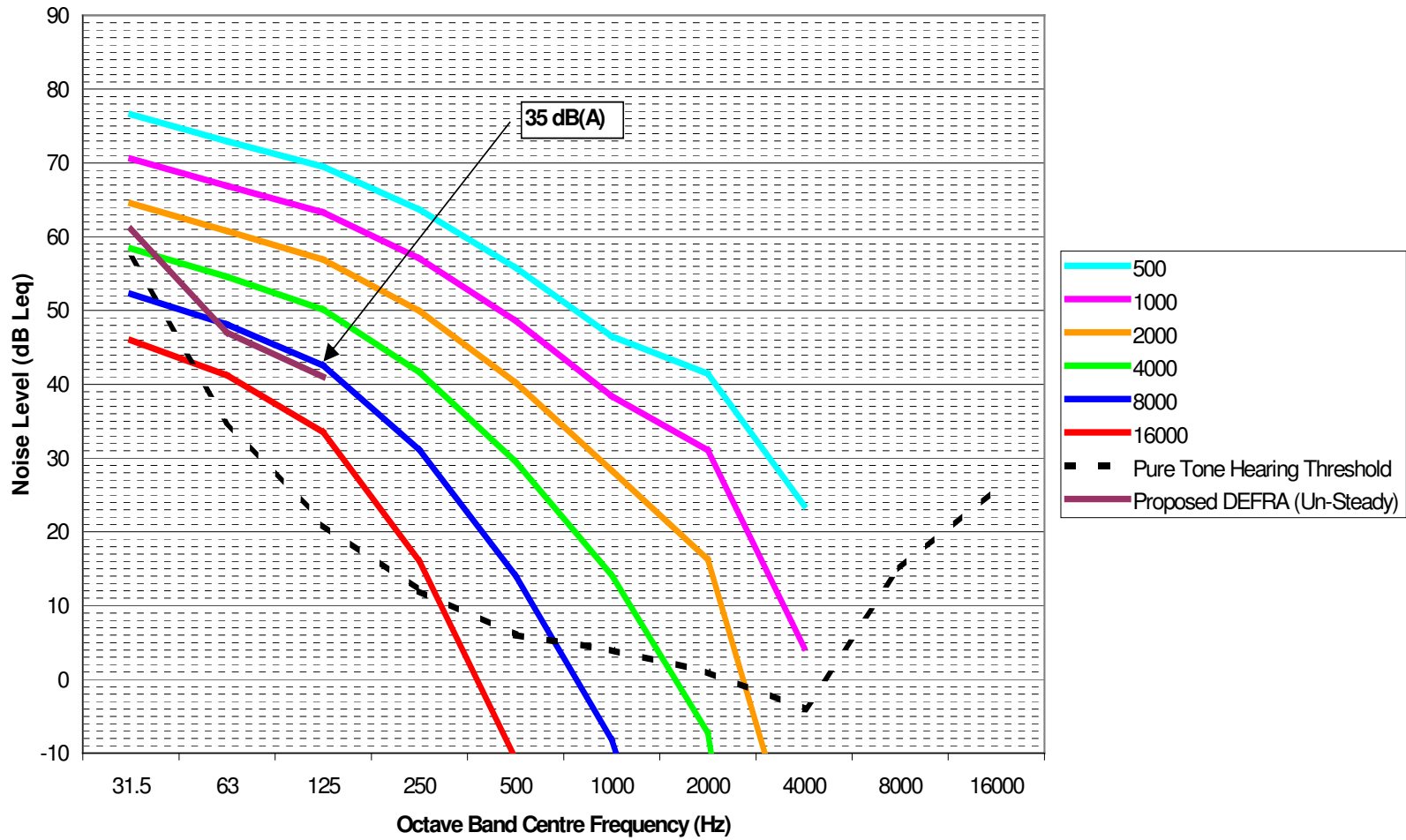
Wind Farm Noise - Spectral Analysis Internal Noise Levels - 8 Turbines



Wind Farm Noise - Spectral Analysis Internal Noise Levels - 50 Turbines



Wind Farm Noise - Spectral Analysis Internal Noise Levels - 500 Turbines



Vibration – The Issues

- Discomfort
- Concern for Structural Damage
- Re-radiated Ground-Borne Noise



Vibration from Wind Turbines

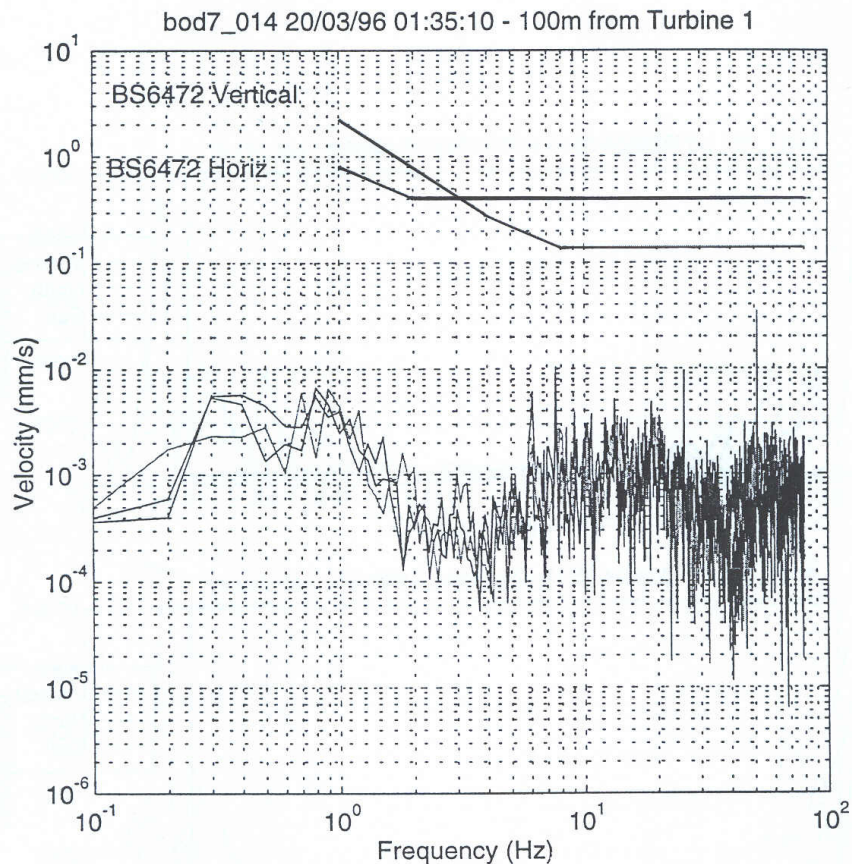


Figure 37

Comparison with BS6472 vibration criteria for critical working areas

from ETSU
W/13/00392/REP: Low
Frequency Noise and
Vibrations Measurement at
a Modern Wind Farm



Vibration from Wind Farm Sites

- Level of Vibration:

approx 10^{-5} mm/s for a 1 MW turbine @ 1km

approx 10^{-4} mm/s for 10 turbines

Prof P Styles, Keele University

- In line with results of previous study



Conclusions

- Infra-Sound (<20Hz)
 - Well below established threshold for most sensitive 5-10% of the population
 - *“no reliable evidence that infrasounds below the hearing threshold produce physiological or psychological effects”* *Community Noise for WHO*



Conclusions

- Low Frequency Noise (20Hz – 100Hz)
 - Wind turbines produce broad band not low frequency noise.
 - However, at long distances higher frequencies are reduced and masked by ambient noise.
 - Lower frequencies may be distinguishing feature of turbine noise under some circumstances. Avoid potential problems by designing to low overall 'A' weighted level.



Conclusions

- Vibration
 - Well below UK criteria for ‘critical working areas’ at 100 m from turbine

